

Table 1. LSDS Platform Parameters and Error Conditions

Sensor	Primary Life Sign Parameter	Additional Data	Error Conditions from Sensor
R-Wave Detector	HR	Presence of signal (Yes or No) Heart rate variability	Leads Off Noisy Lead Signal not detected Out of range – high Out of range – low Sensor INOP
Temperature Sensor	Temp (an estimate of core body temperature value based on External Body Temperature as affected by ambient temperature)	External body temperature	Signal not detected Out of range – high Out of range – low Sensor INOP
Accelerometer	Speed of motion (None, Slow, Medium, High, or Off-scale Shock)	Body Position (Vertical/Upright, Vertical/Up-side-down, Horizontal)	Sensor INOP
Respiration	Presence of Respiration (Yes or No)	Respiration Rate Tidal volume indicator Time since last breath Presence of motion	Bad signal (voltage too high or too low) No breath detected Out of range – high Out of range – low Sensor INOP
Other Information from Sensor Platform	Platform ID (device serial number, or possibly soldier ID number)	Time Stamp of data packet	Low Battery

Table 2. Default Health State Classification Descriptions

Overall Health State	Color Code
Alive	🟢 Green
Alive, but significantly outside “normal”	🟡 Yellow
Dead	🔴 Red
Uncertain (Incomplete or conflicting information from sensors)	🔵 Blue
SENSOR PLATFORM NOT OPERATING (Determined by receiving platform, e.g., no data received at for a given prolonged interval)	⬛ Black

Table 3. Default Life Signs Interpretation Rules for Alive/Green and Dead/Red States

Available Parameters	Interpretation Rule	
	Alive/Green	Dead/Red
HR only	HR \leq 160 BPM and HR \geq 40 BPM for 8 seconds or more	HR = 0 for 4 minutes or more HR <30 BPM for 10 minutes or more
RR only	RR \leq 30 breaths/minute and RR \geq 8 breaths/minutes for 8 seconds or more	RR = 0 for 5 minutes or more
Acceleration/Position only	Insufficient to determine this state	Insufficient to determine this state
Temp only	Insufficient to determine this state	Insufficient to determine this state
HR and RR	[HR \leq 160 BPM and HR \geq 40 BPM and (RR \leq 30 breaths/minute and \geq 8 breaths/minutes)] for 8 seconds or more	HR = 0 and RR = 0 for 4 minutes or more
HR and Acceleration/Position	(HR \leq 160 BPM and HR \geq 40 BPM) and any acceleration value and any position value for 8 seconds or more (HR > 160 /BPM and HR \leq 220 BPM) and (Acceleration is Medium or Fast for any Position value) for 8 seconds or more	HR = 0 and Acceleration is NONE (for any position value) for 4 minutes or more
HR and Temp	(HR \leq 160 BPM and HR \geq 40 BPM) and (Temp = NORMAL) for 8 seconds or more	HR = 0 and Temp \neq NORMAL for 4 minutes or more
RR and Acceleration /Position	RR \leq 30 breaths/minute and RR \geq 8 breaths/minutes and any acceleration value and any position value for 8 seconds or more [(RR >30 breaths per minute and RR \leq 45 breaths per minute) and Acceleration is Fast, for any Position value)] for 8 seconds or more	RR = 0 and Acceleration = NONE (any Position value) for 5 minutes or more
RR and Temp	RR \leq 30 breaths/minute and RR \geq 8 breaths/minutes and Temp is NORMAL for 8 seconds or more	RR = 0 and Temp \neq NORMAL for 5 minutes or more
Acceleration /Position and Temp	Insufficient to determine this state	Insufficient to determine this state
HR, RR, and Acceleration /Position	[(HR \leq 160 BPM and HR \geq 40 BPM) and (RR \leq 30 breaths/minute and RR \geq 8 breaths/minutes) and (any acceleration value and any position value)] for 8 seconds or more [(HR > 160 /BPM and HR \leq 220 BPM) and (RR >30 breaths per minute and RR \leq 45 breaths per minute) and Acceleration is Fast, for any Position value)] for 8 seconds or more	[(HR = 0) and (RR = 0) and (Acceleration is NONE for any Position value)] for 4 minutes or more
HR, RR, and Temp	[(HR \leq 160 BPM and HR \geq 40	[(HR = 0) and (RR = 0) and (any

	BPM) and (RR \leq 30 breaths/minute and RR \geq 8 breaths/minutes) and (Temp is NORMAL)] for 8 seconds or more	Temp \neq NORMAL)] for 4 minutes or more
HR, Acceleration/Position and Temp	<p>[(HR \leq 160 BPM and HR \geq 40 BPM) and (any acceleration value and any position value) and Temp is NORMAL] for 8 seconds or more</p> <p>[(HR $>$ 160 /BPM and HR \leq 220 BPM) and (RR $>$ 30 breaths per minute and RR \leq 45 breaths per minute) and (Acceleration is Fast, for any Position value) and Temp is NORMAL] for 8 seconds or more</p>	[(HR = 0) and (Acceleration is NONE for any position value) and Temp \neq NORMAL)] for 4 minutes or more
RR, Acceleration /Position and Temp	<p>[(RR \leq 30 breaths/minute and RR \geq 8 breaths/minutes) and (any acceleration value and any position value) and Temp is NORMAL] for 8 seconds or more</p> <p>[(RR $>$ 30 breaths per minute and RR \leq 45 breaths per minute) and (Acceleration is Fast, for any Position value) and Temp is NORMAL] for 8 seconds or more</p>	[(RR = 0) and (Acceleration = NONE for any Position value) and Temp \neq NORMAL)] for 5 minutes or more
HR, RR, Acceleration /Position and Temp	<p>[(HR \leq 160 BPM and HR \geq 40 BPM) and (RR \leq 30 breaths/minute and RR \geq 8 breaths/minutes) and (any acceleration value and any position value) and Temp is NORMAL] for 8 seconds or more</p> <p>[(HR $>$ 160 /BPM and HR \leq 220 BPM) and (RR $>$ 30 breaths per minute and RR \leq 45 breaths per minute) and Acceleration is Fast, for any Position value) and Temp is NORMAL] for 8 seconds or more</p>	[(HR = 0) and (RR = 0) and (Acceleration is NONE for any Position value) and Temp \neq NORMAL] for 4 minutes or more

Table 4. Default Life Signs Interpretation Rules for Alive/Yellow State

Available Parameters	Interpretation Rules
HR only	[(HR < 40 BPM and HR ≠ 0 BPM) or (HR > 160 BPM)] for 8 seconds or more
RR only	[(RR < 8 breaths/min and RR ≠ 0 breaths/min) or RR > 30 breaths/min] for 8 seconds or more
Acceleration only	Insufficient to determine this state
Temp only	Insufficient to determine this state
HR and RR	[(HR < 40 BPM and HR ≠ 0 BPM) and/or (HR > 160 BPM) or (RR < 8 breaths/min and RR ≠ 0 breaths/min) or RR > 30 breaths/min] for 8 seconds or more
HR and Acceleration	[(HR < 40 BPM and HR ≠ 0 BPM and any acceleration value) or (HR > 160 BPM and Acceleration is NONE)] for 8 seconds or more
HR and Temp	[(HR < 40 BPM and HR ≠ 0 BPM for any Temp value) or (HR > 160 BPM and Acceleration < Medium for any Position value and any Temp value)] for 8 seconds or more
RR and Acceleration /Position	[(RR < 8 breaths/min and RR ≠ 0 breaths/min and any acceleration value and any position value) or (RR > 30 breaths/min and Acceleration < Medium for any Position value)] for 8 seconds or more
RR and Temp	[(RR < 8 breaths/min and RR ≠ 0 breaths/min and any Temp value) or (RR > 30 breaths/min and any Temp value)] for 8 seconds or more
Acceleration /Position and Temp	Insufficient to determine this state
HR, RR, and Acceleration /Position	[(HR < 40 BPM and HR ≠ 0 BPM) and/or (RR < 8 breaths/min and RR ≠ 0 breaths/min) for any Acceleration value and any Position value] for 8 seconds or more [(HR > 160 BPM and/or RR > 30 breaths/min) and Acceleration < Medium for any position value] for 8 seconds or more
HR, RR, and Temp	[(HR < 40 BPM and HR ≠ 0 BPM) and/or (RR < 8 breaths/min and RR ≠ 0 breaths/min) and any Temp value] for 8 seconds or more [(HR > 160 BPM and/or RR > 30 breaths/min) and any Temp value] for 8 seconds or more
HR, Acceleration/Position and Temp	[(HR < 40 BPM and HR ≠ 0 BPM and any acceleration value and any Temp value) or (HR > 160 BPM and Acceleration < Medium and any Temp value)] for 8 seconds or more
RR, Acceleration /Position and Temp	[(RR < 8 breaths/min and RR ≠ 0 breaths/min and any acceleration value and any position value and any Temp value) or (RR > 30 breaths/min and Acceleration < Medium for any position value and any Temp value)] for 8 seconds or more
HR, RR, Acceleration /Position and Temp	[(HR < 40 BPM and HR ≠ 0 BPM) and/or (RR < 8 breaths/min and RR ≠ 0 breaths/min) for any Acceleration value and any Position value and any Temp value] for 8 seconds or more [(HR > 160 BPM and/or RR > 30 breaths/min) and Acceleration < Medium for any Position value and any Temp value] for 8 seconds or more

Table 5. Default LSDS Alive/Normal Data Ranges

Sensor	Parameter	Data Description (Raw Data Range)	"Normal" Range
R-Wave Detector	Heart Rate	Numeric (0 BPM, and 15 – 250 BPM)	40 – 160 BPM
	Presence of Heartbeat	Boolean (T or F)	TRUE
Respiration Detector	Presence of Respiration	Boolean (T or F)	TRUE
	Respiration Rate	Numeric (0 – 60 breaths/min)	8 – 30 breaths/min
	Tidal Volume Indicator (High, Medium, Low)	Integer (2, 1, 0)	High, Medium or Low
	Time Elapsed Since Last Breath	Numeric (0 – 60 seconds)	Not applicable
	Presence of Motion	Boolean (T or F)	TRUE or FALSE
Accelerometer	Speed (None, Slow, Medium, Fast)	Integer (0, 1, 2, or 3)	0 - 3
	Position (Upright, Horizontal, or Upside- Down)	Signed Integer (1, 0, or -1)	0 - 1
Temperature sensor	Estimated Core Temperature	Numeric (0 - 50°C)	NORMAL (36.4°C – 38.9°C)
	External Temperature	Numeric (0 - 50°C)	Not applicable

Table 6. Default LSDS Alive/Not-Normal Data Ranges

Parameter	Abnormal High	Abnormal Low
HR	161 and higher	39 and lower
RR	31 and higher	7 and lower
Skin Temp	>39°C	<36°C
Acceleration	Not Applicable	Not Applicable
Position	Not Applicable	Not Applicable

Table 8. Default Decision Matrix for Only One Parameter in Last Decision Interval

Parameter	Value	New State	Value	New State	Value	New State	Value	New State
HR	Normal	Alive	Abnormal	Alive- Not- Normal	0 BPM	Dead	Present, can't calculate	Uncertain
RR	Normal	Alive	Abnormal	Alive- Not- Normal	0 breaths per min	Dead	Present, can't calculate	Uncertain
Acceleration	Any	Uncertain						
Position	Any	Uncertain						
Temp	Any	Uncertain						

Table 9. Default Decision Matrix for Two Parameters in Last Decision Interval

Parameters	Average Value Range 1	Average Value Range 2	Average Value Range 3*	New State
HR and RR	Normal	Normal		Alive
	Normal	Abnormal		Alive
	Normal	0		Alive/Not Normal
	Abnormal	Normal		Alive/Not Normal
	Abnormal	Abnormal		Alive/Not Normal
	Abnormal	0		Alive/Not Normal
	0	Normal		Alive/Not Normal
	0	Abnormal		Alive/Not Normal
HR and Acceleration/Position	0	0		Dead
	Normal	Any	Any	Alive
	Abnormal High	Fast	Any	Alive
	Abnormal High	Non-Fast	Any	Alive/ Not Normal
	Abnormal Low	None	Any	Alive/Not Normal
	Abnormal Low	Non-zero	Any	Alive/Not Normal
	0	Any	Any	Dead
	0	0		Dead
HR and Temp	Normal	Normal		Alive
	Normal	H or L		Alive/Not Normal
	Abnormal	Normal		Alive/Not Normal
	Abnormal	H or L		Alive/Not Normal
	0	Any		Dead
RR and Acceleration/Position	Normal	Any	Any	Alive
	Abnormal High	Fast	Any	Alive
	Abnormal High	Non-Fast	Any	Alive/Not Normal
	Abnormal Low	None	Any	Alive/Not Normal
	Abnormal Low	Non-zero	Any	Uncertain
	0	Any	Any	Dead
RR and Temp	Normal	Normal		Alive
	Normal	Abnormal		Alive/Not Normal
	Abnormal	Normal		Alive/Not Normal
	Abnormal	Abnormal		Alive/Not Normal
	0	Normal		Dead
	0	Abnormal		Dead
Temp and Acceleration	Any	Any	Any	Uncertain

*Note that the third value range is only filled in for acceleration (acceleration and orientation).

Table 10. Default Decision Matrix for Three Parameters for Last Decision Interval

Parameters	Average Value Range 1	Average Value Range 2	Average Value Range 3	Average Value Range 4*	New State
HR, RR, and Acceleration	Normal	Normal	Any	Any	Alive
	Normal	Abnormal	Any	Any	Alive/Not Normal
	Normal	0	Any	Any	Alive/Not Normal
	Abnormal High	Normal	Any	Any	Alive/Not Normal
	Abnormal High	Abnormal High	Fast	Any	Alive
	Abnormal High	Abnormal High	Non-Fast	Any	Alive/Not Normal
	Abnormal High	Abnormal Low	Any	Any	Alive/Not Normal
	Abnormal High	0	Any	Any	Alive/Not Normal
	Abnormal Low	Normal	Any	Any	Alive/Not Normal
	Abnormal Low	Abnormal	Any	Any	Alive/Not Normal
	Abnormal Low	0	Any	Any	Alive/Not Normal
	0	Normal	Any	Any	Alive/Not Normal
	0	Abnormal	Any	Any	Alive/Not Normal
	0	0	Any	Any	Dead
HR, RR, and Temp	Normal	Normal	Any		Alive
	Normal	Abnormal	Any		Alive/Not Normal
	Normal	0	Any		Alive/Not Normal
	Abnormal	Normal	Any		Alive/Not Normal
	Abnormal	Abnormal	Any		Alive/Not Normal
	Abnormal	0	Any		Alive/Not Normal
	0	Normal	Any		Alive/Not Normal
	0	Abnormal	Any		Alive/Not Normal
HR, Temp, and Acceleration	0	0	Any		Dead
	Normal	Normal	Any	Any	Alive
	Normal	H or L	Any	Any	Alive/Not Normal
	Abnormal High	Normal	Fast	Any	Alive
	Abnormal High	Normal	Non-Fast	Any	Alive/Not Normal
	Abnormal High	Abnormal	Any	Any	Alive/Not Normal
	Abnormal Low	Any	Any	Any	Alive/Not Normal
RR, Temp and Acceleration	0	Any	Any	Any	Dead
	Normal	Normal	Any	Any	Alive
	Normal	Abnormal	Any	Any	Alive/Not Normal
	Abnormal High	Normal	Fast	Any	Alive
	Abnormal High	Normal	Non-Fast	Any	Alive/Not Normal
	Abnormal High	Abnormal	Any	Any	Alive/Not Normal
	Abnormal Low	Any	Any	Any	Alive/Not Normal
0	Any	Any	Any	Any	Dead

*Note that the fourth value range is only filled in for acceleration (acceleration and orientation).

Table 11. Default Decision Matrix for Four Parameters in Last Decision Interval

Parameters	Average Value Range 1	Average Value Range 2	Average Value Range 3	Average Value Range 4	Average Value Range 5	New State
HR, RR, Temp and Acceleration	Normal	Normal	Normal	Any	Any	Alive
	Normal	Normal	Abnormal	Any	Any	Alive
	Normal	Abnormal	Any	Any	Any	Alive/Not Normal
	Normal	0	Any	Any	Any	Alive/Not Normal
	Abnormal	Normal	*Any	Any	Any	Alive/Not Normal
	Abnormal High	Abnormal High	Any	Fast	Any	Alive
	Abnormal High	Abnormal High	Any	Non-Fast	Any	Alive/Not Normal
	Abnormal High	Normal	Any	Any	Any	Alive/Not Normal
	Abnormal High	Abnormal Low	Any	Any	Any	Alive/Not Normal
	Abnormal High	0	Any	Any	Any	Alive/Not Normal
	Abnormal Low	Normal	Any	Any	Any	Alive/Not Normal
	Abnormal Low	Abnormal	Any	Any	Any	Alive/Not Normal
	Abnormal Low	0	Any	Any	Any	Alive/Not Normal
	0	Normal	Any	Any	Any	Alive/Not Normal
	0	Abnormal	Any	Any	Any	Alive/Not Normal
	0	0	Any	Any	Any	Dead

*Note that the fifth value range is only filled in for acceleration (acceleration and orientation).

Table 12: State Change Score Components

# of State Change Steps	Variations	Total Probability	State Change Score	Influence on Conf Score
0	$G \leftrightarrow G, Y \leftrightarrow Y, R \leftrightarrow R$	60%	3	H
1	$RH \leftrightarrow YH, YH \leftrightarrow G, G \leftrightarrow YL, YL \leftrightarrow RL$	30%	2	M
2 or More	$G \leftrightarrow RH, G \leftrightarrow RL$	10%	1	L

Table 13. Persistence Score Components

Total # Times In New State	Score Range (Total -1)	Influence on Conf Score
7 - 8	6 - 7	H
5 - 6	4 - 5	M
4	3	L

Table 14. Components of Weight (Multiplier) by Parameter Set

Parameter Included in New State	Weight (Multiplier)	Influence on Conf Score
All	1.0	H
HR, RR, and Motion		
HR, RR, Temp	0.9	M
HR and RR		
HR and Temp	0.8	L
HR and Motion		
HR		
RR and Temp		
RR and Motion		
RR		

Table 15. Confidence Score Ranges

Confidence Level	Score Range
High	$80 < \text{Score} \leq 100$
Medium	$50 < \text{Score} \leq 80$
Low	$\text{Score} < 50$

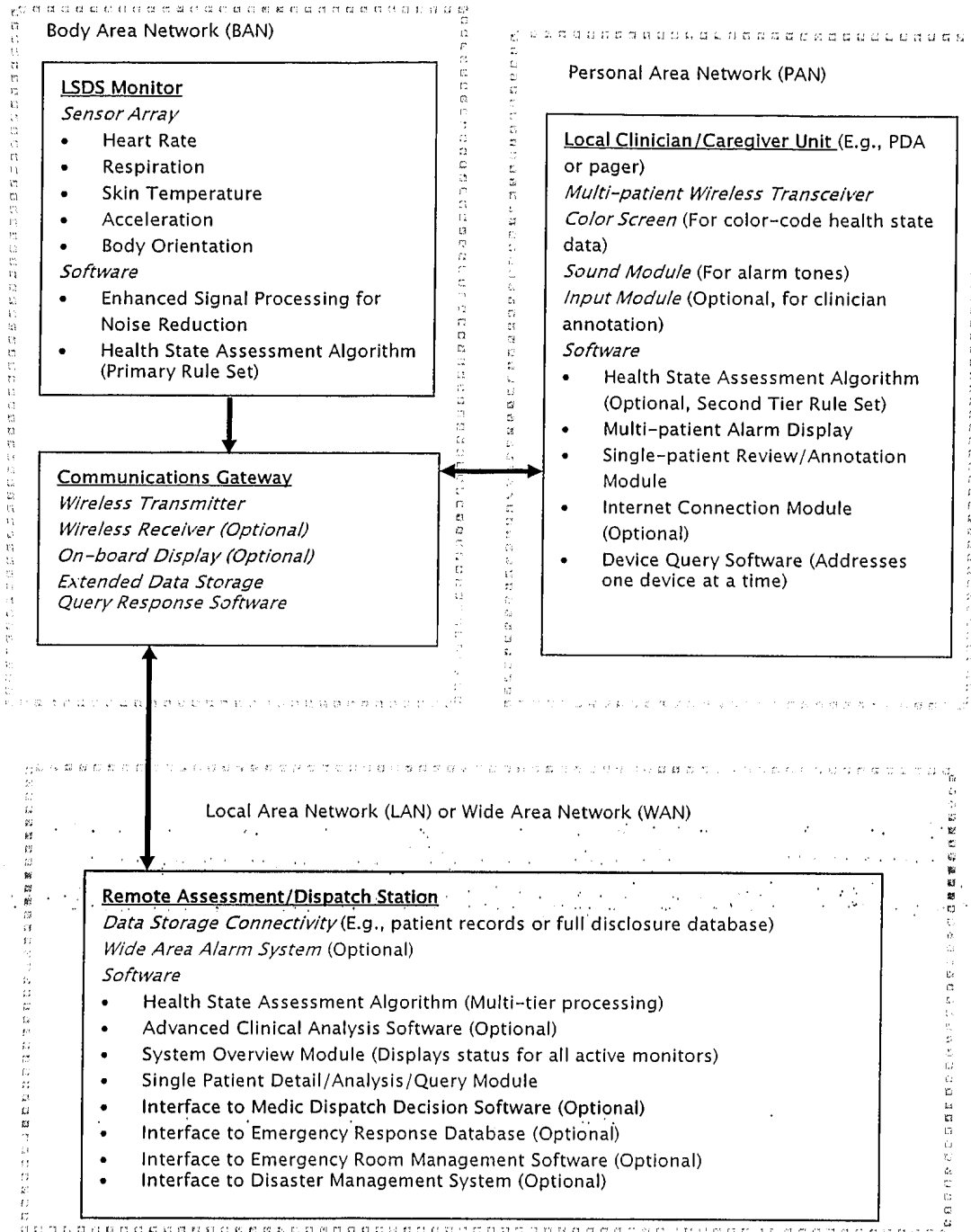


Figure 48 - Block Diagram :Life Signs Detection System